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Poster presentation

How crickets determine the direction of a flow field

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Crickets and other orthoptera such as locusts and cockroaches possess two sensory organs, called cerci, on the back of their body. The cerci are covered by a variety of different sensor types, viz., acceleration sensors, chemoreceptors, touch sensors and, what we focus on here, flow sensors. Flow senors, also called filiform hairs, consist of a long thin hair, coupling viscously to the motion of the surrounding air, and a mechano-sensory hair cell, translating hair deflection into spikes emitted into ascending nerve fibers. The ascending axons project into the terminal abdominal ganglion and form a map, representing the direction of the air flow around the cerci. Four of the interneurons (R10-2a, R10-3a, L10-2a and L10-3a) arising from the cricket's terminal abdominal ganglion seem to encode the direction of the flow field by voting through maximal firing rates for one of four directions approximately given by 45°, 135°, 225° and 315° with respect to the long axis of the cricket in its plane of motion [1]. Behavioral studies e.g., [2], indicate that determining the stimulus direction is an essential feature of an appropriate response.

We propose that the four interneurons implement a population vector code and show that it is capable of estimating the direction properly. To test this hypothesis, we have computed a realistic flow field around the cerci caused by an attacking predator so as to determine the stimulus to the sensor system during attack. A good description of the motion of a filiform hair is that of a harmonic oscillator with the hair oscillating in the plane of preferred direction. By applying the population vector code to randomly distributed hairs of different lengths and directions all over a cercus, we obtain a good neuronal reconstruction of the direction of an attacking predator.

References

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